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A PRELIMINARY REPORT ON SOME OF THE SECONDARY COLEOPTERA
ASSOCIATED WITH D. BREVICOMIS

By

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INTRODUCTION

A large number of secondary insects enter the bark of western yellow pine, following the successful development of D. brevicomis broods. Among them are several genera of Coleoptera representing different families. They are probably more closely associated with D. brevicomis than those belonging to the orders Diptera, Hymenoptera, and Neuroptera. There is need of a greater knowledge of the interrelation of these secondary forms and their effect on the development of D. brevicomis broods. They are always present and each species of insect bears an important relation to the others in regard to food supply as well as in regard to a place to develop a brood. Some of them are predaceous on adult forms, others on immature stages. Still others are scavengers which feed on frass or other decomposed organic matter. Some of them also are dependent upon fungi which grow abundantly on decomposed and putrefying organic matter in the D. brevicomis galleries. So with this complicated interdependence of one insect form on another whether predaceous, scavenger, or phytophagus, there is a struggle going on which undoubtedly has a great deal of influence on the western pine beetle.

There is no recent literature bearing on this subject. A few notes have been taken from time to time by men working in the field, but published works are entirely lacking. H. L. Person (19) has studied the life histories and habits of two important predators of D. brevicomis in considerable detail. These are a Clerid, Enoclerus lecontei Wolcott (Thanasimus nigriventris Lec.) and an Ostomid, Temnochila virescens Fabr. var. chlorodia Mann. He also indicates the probable predatory nature of other Coleopterous insects found commonly in D. brevicomis galleries; namely, the colydiid Aulonium longum Lec., a tenebrionid Hypophloeus parallelus Melsh., and a cucujid, Cucujus calvipes Fabr. var. puniceus Mann. Cucujus clavipes Fabr. is found actually to be predatory, but has little effect on D. brevicomis on account of the fact that it enters abandoned trees only.

The purpose of this report is to assemble data on a few of the more important secondary coleoptera associated with D. brevicomis, preliminary to further studies on the ecology of these forms and on their importance in relation to D. brevicomis development. Owing to the short time available, this study was limited chiefly to work on the life histories and habits of Platysoma punctigerum Lec. and Hypophloeus parallelus Melsh. Notes on other insects were also taken. Special attention was given to larval and pupal identity.

with Polygraphus rufipennis and Liagomum americanum Melsh was found with Dryocoetes autographus in spruce bark. Hopkins also speaks of predaceous Staphylinid larvae with Ips pini in pine bark.

Nudobius cephalus (Say)

Rearing Notes.

On June 26 several larvae thought to be those of Nudobius were placed in a vial to rear. They all died, however, within a few days. On July 16 a prepupal larva thought to be Nudobius was placed in a vial to rear. On August 3 a Nudobius adult was present. The pupal stage was not observed. Pupae thought to be those of Nudobius were gathered on September 15 in a tree (L-100) which had been killed by D.brevicomis in June. One of these emerged as an adult by September 26, making certain the identity of pupae.

Pupation takes place under the bark in the decaying and fungus-infested phloem. No special cells are constructed. The pupae are dark yellow, rather elongate, being enlarged toward the head.

The feeding habits of Nudobius are uncertain. They are thought to be predaceous, but there is no positive assurance of what they prey upon. No experiments were undertaken with Phloeonomus. They were observed to be common under the bark of trees which had been dead for over a month. Phloeonomus is thought to feed on fungus material.

SUMMARY

1. A study was made on some of the secondary Coleoptera associated with D.brevicomis during the summer of 1928 at Willow Ranch, California. Insects included in this study were two Histerids, Platysoma punctigerum Lec., and Plegaderus nitidus Horn, a Tenebrionid, Hypophloeus parallelus Melsh, and two Staphylinids, Nudobius cephalus (Say) and Phloeonomus pusillus (Grav.)

2. Platysoma punctigerum was found to be a predaceous insect, feeding voraciously on D.brevicomis. It is also suspected of feeding on other adult insects and to be cannibalistic. Their importance as a natural enemy of D.brevicomis is small owing to the fact that they enter trees after D.brevicomis have almost completed laying their eggs.

Life history on this species indicate one complete generation and a partial second per year. Its rate of development is slightly slower than that of D.brevicomis. (See Plate II for rate of development compared with D.brevicomis).

3. Plegaderus nitidus is thought to feed on fungus material in D.brevicomis galleries. Large groups of this species were seen among a greenish fungus on many occasions. Groups of them were also seen in D.brevicomis frass. Rearing experiments with this species were unsuccessful.

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4. Notes on the life history of Hypophloeus paralleus indicate that its rate of development is the same as Platysoma. Both insects enter the bark about the same time through D.brevicomis ventilation holes. No special experiments were conducted to study the feeding habits of Hypophloeus.

5. Nudobius cephalus is thought to be a predaceous insect, but its host or hosts has not been determined. Rearing experiments were conducted and positive identification of larvae and pupae of this species was obtained.

6. Plate I figures the life history stages of Platysoma punctigerum.

The data assembled herein were gathered in a western yellow pine type area in Modoc county during the summer of 1928. This area, located in the Warner Mountains near Willow Ranch, ranges in elevation between 5000 and 5600 feet. It has suffered from a fairly heavy D.brevicomis infestation, but is rapidly approaching endemic proportions.

The insects dealt with in this study are listed in the order to be taken up:

Order Coleoptera

Family Histeridae

Platysoma punctigerum Lec.

Plegaderus nitidus Horn.

Family Tenebrionidae

Hypophloeus parallelus Melsh.

Family Staphylinidae

Nudobius cephalus (Say)

Phloeonomus pusillus (Grav.)

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HISTERIDAE

Members of the family Histeridae are commonly found in association with bark beetles in all parts of the country. No special work has been done with them, however, aside from collecting and identifying. Hopkins(5-1893) reports several species associated with various Scolytids of West Virginia, but does not indicate the feeding habits of any. Species which are closely related to the common forms found here have been mentioned by W. A. Clemens(2-1916) and Leonard(8-1928) both of Cornell. Clemens has taken Platysoma coarctatus Lec. from the burrows of Ips pini. Leonard reports Plegaderus transversus Say. from galleries of Tomicus (Ips) calligraphus and in dead pine from different localities of New York state. Plegaderus transversus Say. is also mentioned by Hopkins(5-1893) as occurring with Ips calligraphus in pine bark.

Platysoma punctigerum Lec.

Platysoma punctigerum Lec. is the most important histerid associated with the western pine beetle. It is found to be positively predaceous, feeding on D.brevicomis which are confined in their egg galleries or some other tight place. It is not very important as a control factor for D.brevicomis, however, owing to the fact that it enters trees when the western pine beetle has practically completed laying eggs. Platysoma is a medium small, shining black insect 4-5 mm. long and about 2 mm. wide. It is rather

sluggish in its movement and has a tendency to feign dead when disturbed. The larvae of this species are also predaceous, feeding on Dipterous and other small larvae. They are creamy white with rather heavily chitinized head and prothorax. The larvae are also characterized by two prominent, two-segmented anal cerci, each cercus having two conspicuous terminal hairs. (See Plate I). The cerci are much reduced in the pupal stage and are entirely lacking in the adult. The eggs of Platysoma were not found.

Life History.

Platysoma adults are attracted to trees within two or three weeks after they have been overcome by D.brevicomis. The histerids enter the bark through ventilation holes and wander about in the D.brevicomis.egg galleries where they prey upon D.brevicomis parent adults. Oviposition probably takes place in the D.brevicomis egg gallery. When Platysoma eggs hatch the larvae crawl about the galleries in search of food material which probably consists of small Dipterous and other larvae. An actual observation of a Platysoma larva feeding on a Dipterous larva was made by the writer during the summer. The grasp on the Dipterous larva was so firm that when put in alcohol both larvae were preserved in position. Platysoma larvae develop rapidly and are fully grown by the time D.brevicomis have completely emerged. They hollow out unlined egg-shaped pupal cells in the D.brevicomis frass where they pupate. Emergence starts from three weeks to a month following that of D.brevicomis and continues for a considerable length of time.

No observations were made to determine in which stage Platysoma spend the winter. Indications are that they overwinter in the adult stage under the bark. Large numbers of adults were found in several over-wintering D.brevicomis trees that were felled during June. It is probable that they also over-winter in the larval stage.

There are probably two generations of Platysoma produced each year. The summer brood which starts about July 1 matures by the middle of August. The second generation enters Generation II D.brevicomis trees between August 20 and September 15 to start new broods or over-winter in the adult stage. (See Plate II).

Life history notes on Platysoma punctigerum were taken from time to time during the summer. Experiments were also conducted to stimulate, if possible, the production of eggs and larvae. These experiments were unsuccessful, however, with the exception of one case in which a small larva was reared from the egg stage. Information relative to oviposition is entirely lacking as yet.

Notes which were taken in the field during July, August, and September indicate that the development of Platysoma parallels rather closely that of D.brevicomis. Platysoma adults were invariably present within one to three weeks after the successful attack of D.brevicomis or shortly after ventilation holes were made. Small Platysoma larvae were always found at the time D.brevicomis were in the fully-grown larval and pupal stage.

The following table sums up notes taken:

Date 1928	Stage of <u>Platy-</u> soma brood	Stage of <u>D.b.</u> brood	Tree Number
June 26	New adults	Abandoned	KW- 2
July 2	0 to 1/4-grown larvae	Fully-grown larv., pup., new adults.	L-100
July 27	1/3 to 1/2 grown larvae	New adults to emerging	L-summer
August 8	Pupae	Aband. Few hold- over pupae and new adults	L-100
August 14	New adults	Aband. few hold- over pupae and new adults	L-100
August 22	Fully-grown larvae, pupae	New adults, emerging	L-18
August 30	Fully-grown larvae, pre- pupae, pupae.	Aband. 3 weeks	L-22

Positive identification of larval and pupal forms were made by rearing under controlled conditions and by field observation. Rearing in the laboratory consisted in collecting pre-pupal larvae and pupae and placing them in vials where they were allowed to transform to the adult stage. Experiments were tried in order to stimulate oviposition, but failed. Plate I figures all developmental stages of Platysoma beyond the egg stage.

Feeding Experiments.

Some experiments were carried on with Platysoma adults during July and August to determine whether they were predatory or scavengers, and as far as possible to determine of what their food consisted. The insects were thought to be predatory on account of their large, extending mandibles. Both dead and living material were used, however, to confirm this assumption.

The experiments were conducted by placing Platysoma punctigerum adults in vials with the material to be consumed. Other materials such as D.brevicomis frass and decaying phloem as found under the bark of freshly killed D.brevicomis trees, were also placed in some of the vials in order to make conditions favorable to laying eggs. Moisture conditions were kept as nearly normal as possible in each vial. All vials were placed in semi-darkness.

1. D.brevicomis eggs. On July 5, four large Platysoma punctigerum adults were placed in a vial with 17 D.brevicomis eggs. On July 13 the vial was examined. All eggs were missing, having been apparently devoured. Only one Platysoma remained in the vial. A small hole bored in the cork indicated that the other three had escaped.

2. Pulverized frass. Four Platysoma adults were placed in a vial with pulverized D.brevicomis frass on July 5 to determine whether they would feed on it and whether they would be stimulated to deposit eggs. The frass was pulverized in order to crush any other eggs that may be present and thus lead to confusion. The vial was examined carefully from time to time until August 20 at which time all of the insects had died. No eggs were laid and there was no evidence of feeding.

3. Sterilized D.brevicomis frass. Four Platysoma adults were placed in a vial of sterilized frass on July 5 to determine whether they would lay eggs. By July 27 no change had taken place. On August 20 the vial was again examined. All the Platysoma had died. One of them was badly torn.

4. D.brevicomis larvae. On July 5 two Platysoma adults were placed with several D.brevicomis larvae. The Platysoma had still left the larvae intact by July 13. On July 27 both the D.brevicomis larvae and the Histerids were dead, but there was no evidence to indicate feeding.

5. Miscellaneous larvae. Two Platysoma adults were placed in a vial with miscellaneous Dipterous and Coleopterous larvae on July 5. The vial was examined from time to time until August 20. Both adults were still alive. The other material had died, but was untouched.

6. Living D.brevicomis adults. Three Histerids were placed in a vial with 5 living D.brevicomis on July 5. On July 13 all Platysoma were present, but the D.brevicomis had been devoured except for elytra, legs, and other heavily chitinized parts. This experiment was repeated. Six Platysoma were placed in a vial with 10 living D.brevicomis adults on July 13. By July 27 three of the Histerids had died, probably on account of excess moisture conditions which were noted to be present. Five of the D.brevicomis were devoured; the others died.

7. Dead D.brevicomis adults. Two Platysoma adults were placed in a vial with 5 dead D.brevicomis adults on July 5 to determine whether they were scavengers. Both had died by July 13. The D.brevicomis were intact.

From the above experiments it is seen that positive results were obtained in only two cases in both of which Platysoma actually fed on living D.brevicomis adults. These results led to other check experiments which were conducted under more natural conditions to stimulate if possible the production of eggs.

Rearing in Glass Jar. A green block of wood with the bark attached was placed in a large glass jar. Twenty-five D.brevicomis adults were introduced to start an attack. A glass top was fitted over the opening to prevent evaporation, but was removed from time to time to prevent the accumulation of moisture. Twenty-five more D.brevicomis were introduced on July 31. By August 7 a good attack had been started. Twenty-five more D.brevicomis were introduced together with twenty Platysoma punctigerum adults. Remains of D.brevicomis were already present within a day after introducing the Histerids, indicating their predatory nature. On August 18 some of the bark was shaved off to note what had taken place. Histerids were found in the galleries as well as the remains of D.brevicomis. Small D.brevicomis larvae had developed by this time, but there was no evidence that Platysoma were feeding on them. On September 5 the bark was completely shaved off to note what had taken place. Not a single D.brevicomis could be found inside the jar or under the bark which had not been attacked. Only eight Platysoma punctigerum adults were found. The remains of D.brevicomis were found strewn over the bottom of the jar. The fact that so few of the Platysoma adults were left tends to indicate cannibalism.

Another experiment similar to the one just described was started on September 5, wherein a closer and more accurate count of beetles was made. A green block of wood with the bark attached was put in the jar as in the previous experiment. The opening of the jar was covered with a strip of muslin instead of the glass top. It was found that by this method a more natural moisture condition was maintained. Fifty D.brevicomis were introduced on September 5 and on September 7 25 more were introduced. By September 8 the D.brevicomis had started a good attack and 50 Platysoma punctigerum adults were introduced. On September 13 a large number of prothoraxes, legs, and other D.brevicomis remains were found. A bit of bark was shaved off on September 17 and D.brevicomis eggs were found. On September 24 the bark was completely shaved off. No brood was found. Counts were made on the insects present. Four living D.brevicomis, 15 dead D.brevicomis, 39 living Platysoma, and 3 dead Platysoma were found. Out of a total of 75 D.brevicomis that were introduced, but 19 could be accounted for. The others were unquestionably devoured. Forty-one of the 50 Platysoma punctigerum adults were accounted for.

It is evident from the above experiments that Platysoma punctigerum adults are predaceous on D.brevicomis, but they may not be of great importance as a control measure on account of the following reasons:

1. It is found that Platysoma usually enter trees which have been attacked by D.brevicomis from two to three weeks following the attack under normal conditions. By this time D.brevicomis have practically completed egg-laying and some of them have abandoned the trees.

2. Platysoma do not attack D.brevicomis unless they are confined in a D.brevicomis gallery or some other tight place on account of the fact that D.brevicomis are more active.

Plegaderus nitidus Horn.

This is a very small, shining, black insect varying in length from $3/4$ to $1-1/2$ mm. It is very common under the bark of trees recently killed by D.brevicomis. Very little is known about its life history and habits.

An experiment was tried in an effort to get Plegaderus to rear a brood. On August 22 thirty adults were placed in the jar with D.brevicomis and Platysoma punctigerum. On September 5, six Plegaderus adults could be found, but no evidence of a brood.

Observations were made by the writer in the field on trees cut during the summer, but practically no information concerning the development of broods was obtainable. Larvae were seen among a group of adults only on two occasions. Positive identification was not obtained.

Nothing is known concerning the feeding habits of Plegaderus. The writer on several occasions noted their presence among a greenish fungus. Whether or not they actually feed on it is uncertain. They were also commonly seen wandering in D.brevicomis frass, but were never seen to be actually feeding on it.

TENEBRIONIDAE

Members of this family are found commonly in the galleries of bark beetles and are usually thought of as predaceous insects. Hypophloeus parallelus Melsh is perhaps one of the commonest forms. This species was taken by W. A. Clemens⁽²⁻¹⁹¹⁶⁾ in the burrows of Ips pini. Hopkins⁽⁵⁻¹⁸⁹³⁾ reports H. parallelus as predaceous. He found it associated with Polygraphus rufipennis in spruce bark, with Tomicus (Ips) calligraphus, Tomicus (Ips) pini, Dendroctonus frontalis, and Crypturgus pusillus in pine bark, and with Chramesus icorae in Hickory bark. H. tenuis Lec. a closely related species has been described by Blackman⁽¹⁻¹⁹¹⁵⁾ as occurring in the burrows of Pityogenes. Specimens were taken from the nuptial chambers,

egg galleries, and feeding burrows of young adults. Packard (1890) reports it predaceous upon Pityophthorus puberulus Lec. and P. sparassus Lec.* Hopkins (5-1899) records H. tenuis as common in the brood galleries of Tomicus (Ips) calligraphus, feeding on adults. Although members of this family are reported to be predaceous, there is nothing in the literature to confirm this assumption.

Hypophloeus parallelus Melsh.

H. parallelus is the commonest tenebrionid under the bark of western yellow pine. The adult is a small, shining, reddish-brown insect about 4 mm. long. The larvae of this species are brownish and rather heavily chitinated. Pupation takes place in the frass of D.brevicomis galleries, but no cells are specially constructed. The development of Hypophloeus parallelus is apparently about the same rate as that of Platysoma punctigerum. Hypophloeus larvae, pupae, and new adults can be found almost invariably at the same time as Platysoma larvae, pupae, and new adults. Although Hypophloeus is generally conceded to be a predaceous insect, the writer is convinced that its importance as a predator of D.brevicomis is negligible. No observations were made to support evidence of predaceous feeding by this insect either in the larval or adult stage.

Hypophloeus parallelusRearing Notes.

An experiment was conducted in which a log 3 feet long by 10 inches in diameter was placed into a can specially constructed to rear insects. This can is 3 feet in height by 18 inches across with tapering bottom and top. A small hole one inch in diameter is left in the bottom and one in the cover to insure proper ventilation. A piece of fine screen was soldered over the hole in the cover; the hole at the bottom of the can was left open. The can is constructed entirely of galvanized iron.

The following table sums up the development of D.brevicomis and Hypophloeus in this experiment:

<u>Date introduced</u>	<u>No.of D.b.</u>	<u>No.of Hypo- phloeus introd.</u>	<u>Stage of D.b.brood</u>	<u>Stage of Hypo- phloeus brood</u>
Aug. 8	50			
9	150		Attack started	
11	100	12-		
18			Many egg gal., eggs, small larvae.	
22		70		
29			Network of egg galleries around log. Eggs to 1/3-grown larvae.	Adults abund- ant in <u>D.b.</u> galleries. No brood.
Sept.5			Parent adults leave log.	
14			Larvae 1/2-1 pupae.	No brood
25			Fully-grown larvae, pupae	No brood

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A very heavy brood of D.brevicomis developed in the log. Moisture conditions were apparently very favorable. Hypophloeus showed no indication of brood development although the adults were abundant in the D.brevicomis galleries. This may be explained by the fact that they were perhaps too old at the time they were introduced. It was difficult to collect new adults in large numbers on account of the unevenness in their development. There was no evidence of predaceous feeding by this insect.

Field Notes.

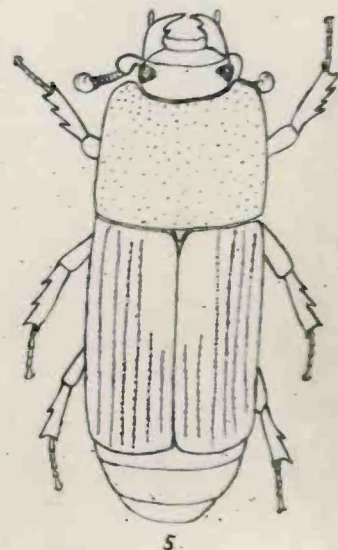
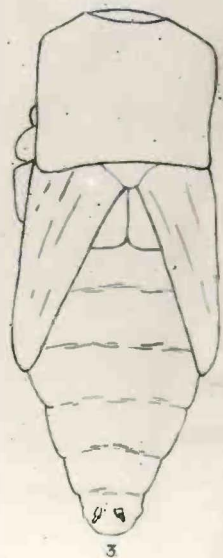
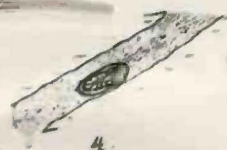
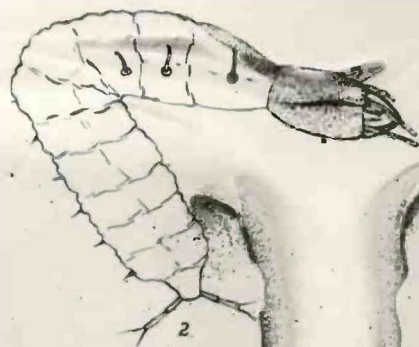
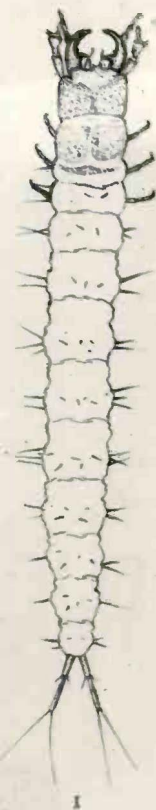
Notes which were taken in the field on Hypophloeus show their developmental stages with relation to D.brevicomis. The following summations are shown:

Date	Tree No.	Stage of <u>Hypo-phloeus</u> broods	Stage of <u>D.b.</u> broods
June 26	KW-2	Pupae	Abandoned
July 7	KW-2	Adult	Abandoned
Aug. 22	L-18	Larvae, pupae, new adults	New adults - mostly emerged.
Aug. 30	L-22	Pupae abundant	Abandoned recently

STAPHYLINIDAE

This family is represented by two species common under the bark of dead western yellow pine. These are Nudobius cephalus, the larger one and Phloeonomus pusillus. Both are described in Keen's "Insect Enemies of California Pines and Their Control" (6-1928) on page 73. Staphylinids are broadly considered in two distinct groups; those which are strictly carrion feeders and those which are general feeders. Nudobius and Phloeonomus undoubtedly belong to the latter group. No studies have been carried on with either of these insects. Kirkwood in a letter read to the Washington Entomological Society (7-1906) described the predaceous nature of Staphylinus maculosus, wherein he observed one to prey upon flies. Hopkins (5-1893) lists several predaceous Staphylinids which are associated with Scolytids. Baptolinus longiceps Fab. was found associated

PLATE I



DEVELOPMENTAL STAGES OF *PLATYSOMA PUNCTIGERUM*
 1. LARVA
 2. PREPUPAL LARVA
 3. PUPA
 4. PUPAL CELL IN D. ~~CELL~~ PEG GALLERY
 5. ADULT

PLATE II

